TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	Attorney's Docket Number 70177
	U.S. Application No (if known, see 37 C.F.R.) 09/890381
INTERNATIONAL APPLICATION NO. PCT/DE00/04217	INTERNATIONAL FILING DATE November 28, 2000
	PRIORITY DATE CLAIMED 30/Nov./1999
TITLE OF INVENTION AXLE SUSPENSION FOR RIGID AXLES OF VEHICLES	
APPLICANT(S) FOR DO/EO/US BUHL et al.	

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. [] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.

3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(C)(2))
   a. [ ] is transmitted herewith (required only If not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).

6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other documents (s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98

12. [] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.

14. [X] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information:
    Formal Drawings (6 sheets)
    Copy of Express Mail Receipt No. EL455157026US
    Copies of Cited References (12)
    Marked Up Copy of the Translation
    Marked Up Copy of the Claims
    Letter Re Drawing Additions & New Figure 7

U.S. Appln No. (if known, see 37 CFR 1.5) 09/890381	International Application No. PCT/DE00/04217	Attorney's Docket Number 70177

17. [X] The following fees are submitted: **BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):**	CALCULATIONS	PTO USE ONLY
Search Report has been prepared by the EPO or JPO $860.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $690.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00		
Neither international preliminary examination fee (37 CFR 1.482 nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ]20 [ ]30 months from the earliest claimed priority date (37 CFR 1.492(e))	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	- 20 =		X $ 18.00	$	
Independent claims	- 3 =		X $ 80.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 860.00	

Reduction of 1/2 for filing small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1,28)	$	
SUBTOTAL =	$ 860.00	
Processing fee of $130.00 for furnishing the English translation late than [ ]20 [ ]30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	$	
TOTAL NATIONAL FEE =	$ 860.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +	$	
TOTAL FEES ENCLOSED =	$ 860.00	
	Amount to be: refunded	$
	charged	$

a. [X] A check in the amount of $ 860.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. 13-0410 in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13.0410. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:

McGLEW AND TUTTLE, P.C.
Scarborough Station
Scarborough, NY 10510-0827

Signature

John James McGlew
Name

31,903
Registration Number

ATTORNEY DOCKET NO: 70177

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : BUHL et al.
PCT No : PCT/DE00/04217
Filed : July 27, 2001
For : AXLE SUSPENSION...
Dated : July 27, 2001

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Prior to initial examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Please replace the specification originally filed, with the enclosed substitute specification. A marked up copy of the original specification is attached. Applicant states that no new matter has been added.

IN THE CLAIMS:

Please amend claims 1 to 9 without prejudice as follows:

1. (AMENDED) An axle suspension for a rigid vehicle axle, the axle suspension comprising:

a four-point connecting rod arranged above the vehicle axle;

two vehicle axle joints connecting two points of said four-point connecting rod to said

vehicle axle in an articulated manner;

two vehicle body joints connecting two points of said four-point connecting rod to a vehicle body in an articulated manner, said two vehicle axle joints being located at spaced locations from one another in a transverse direction of the vehicle and said two vehicle body joints being located at spaced locations from one another in a transverse direction of the vehicle;

an first axle strut extending in a longitudinal direction of the vehicle arranged on a first side of the vehicle for guiding the axle, said first axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

an second axle strut extending in a longitudinal direction of the vehicle arranged on a second side of the vehicle for guiding the axle, said second axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

a spring assembly unit arranged between the vehicle axle and the vehicle body for spring suspension;

a first molecular joint connecting said first axle strut to said vehicle axle;

a second molecular joint connecting said second axle strut to said vehicle axle.

2. (AMENDED) An axle suspension in accordance with claim 1, further comprising another spring assembly unit arranged between the vehicle axle and the vehicle body for spring suspension, said first axle strut having a first mount for said spring assembly unit and said second axle strut having a second mount for said another spring assembly unit.

3. (AMENDED) An axle suspension in accordance with claim 2, wherein said first mount includes a joint and said second mount includes a joint.

4. (AMENDED) An axle suspension in accordance with claim 3, wherein the joints are ball-and-socket joints.

5. (AMENDED) An axle suspension in accordance with claim 1, further comprising a first shock absorber connected between said first axle strut and the vehicle body and a second shock absorber connected between said second axle strut and the vehicle body, said first axle strut having a first mount for said first shock absorber and said second axle strut having a second mount for said second shock absorber.

6. (AMENDED) An axle suspension in accordance with claim 1, further comprising:

a third molecular joint connecting said first axle strut to said vehicle body; and

a forth molecular joint connecting said second axle strut to said vehicle body.

7. (AMENDED) An axle suspension in accordance with claim 6, wherein said third molecular joint connecting said first axle strut to said vehicle body has a stiffer joint characteristic than said first molecular joint connecting said first axle strut to said vehicle axle and said forth molecular joint connecting said second axle strut to said vehicle body has a stiffer joint characteristic than said second molecular joint connecting said second axle strut to said

vehicle axle.

8. (AMENDED) An axle suspension in accordance with claim 1, wherein said spring assembly unit is arranged in front of or behind said vehicle axle.

9. (AMENDED) An axle suspension in accordance with claim 1, wherein said spring assembly unit is arranged in front of and behind said vehicle axle.

Please add the following new claims:

10. (NEW) An axle suspension in accordance with claim 5, wherein said first mount includes a joint and said second mount includes a joint.

11. (NEW) An axle suspension for a rigid vehicle axle of air-suspension utility vehicles, the axle suspension comprising:

a four-point twistable connecting member arranged above the vehicle axle;

two vehicle axle joints connecting two points of said four-point connecting member to said vehicle axle in an articulated manner;

two vehicle body joints connecting two points of said four-point connecting member to a vehicle body in an articulated manner, said two vehicle axle joints being located at spaced locations from one another in a transverse direction of the vehicle and said two vehicle body joints being located at spaced locations from one another in a transverse direction of the vehicle;

an first axle strut extending in a longitudinal direction of the vehicle arranged on a first side of the vehicle for guiding the axle, said first axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

an second axle strut extending in a longitudinal direction of the vehicle arranged on a second side of the vehicle for guiding the axle, said second axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

a spring assembly unit arranged between the vehicle axle and the vehicle body for spring suspension;

another spring assembly unit arranged between the vehicle axle and the vehicle body for spring suspension

a first molecular joint connecting said first axle strut to said vehicle axle;

a second molecular joint connecting said second axle strut to said vehicle axle.

12. (NEW) An axle suspension in accordance with claim 11, wherein said first axle strut has a first mount for said spring assembly unit and said second axle strut has a second mount for said another spring assembly unit.

13. (NEW) An axle suspension in accordance with claim 12, wherein said first mount includes a joint and said second mount includes a joint.

14. (NEW) An axle suspension in accordance with claim 13, wherein the joints are ball-

and-socket joints.

15. (NEW) An axle suspension in accordance with claim 11, further comprising a first shock absorber connected between said first axle strut and the vehicle body and a second shock absorber connected between said second axle strut and the vehicle body, said first axle strut having a first mount for said first shock absorber and said second axle strut having a second mount for said second shock absorber.

16. (NEW) An axle suspension in accordance with claim 15, wherein said first mount includes a ball-and-socket joint and said second mount includes a ball-and-socket joint.

17. (NEW) An axle suspension in accordance with claim 11, further comprising:

a third molecular joint connecting said first axle strut to said vehicle body; and

a forth molecular joint connecting said second axle strut to said vehicle body.

18. (NEW) An axle suspension in accordance with claim 17, wherein said third molecular joint connecting said first axle strut to said vehicle body has a stiffer joint characteristic than said first molecular joint connecting said first axle strut to said vehicle axle and said forth molecular joint connecting said second axle strut to said vehicle body has a stiffer joint characteristic than said second molecular joint connecting said second axle strut to said vehicle axle.

19. (NEW) An axle suspension in accordance with claim 11, wherein said spring assembly unit is arranged in front of or behind the said vehicle axle.

20. (NEW) An axle suspension in accordance with claim 11, wherein said spring assembly unit is arranged in front of and behind said vehicle axle.

REMARKS

Claims 1 through 20 are in this application and are presented for consideration. Claims 10 through 20 have been added. The new and revised claims present subject matter similar to the original claims, but in a different form.

The specification and claims have been amended in order to place this application in better form. The reference to claims in the specification has been deleted or amended. Appropriate headings have been added. No new matter has been added.

Favorable action on the merits is respectfully requested.

Respectfully submitted
for Applicant,

By: _____

John James McGlew
Registration No. 31,903
McGLEW AND TUTTLE, P.C.

JJM:jj/esd

70177 1

Enclosed: Substitute Specification
Marked up copy of Translation
Marked up copy of Claims
New Drawing Sheet 7

DATED: July 27, 2001
SCARBOROUGH STATION
SCARBOROUGH, NEW YORK 10510-0827
(914) 941-5600

SHOULD ANY OTHER FEE BE REQUIRED, THE PATENT AND TRADEMARK OFFICE IS HEREBY REQUESTED TO CHARGE SUCH FEE TO OUR DEPOSIT ACCOUNT 13-0410.

I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS EXPRESS MAIL IN AN ENVELOPE ADDRESSED TO: COMMISSIONER OF PATENTS AND TRADEMARKS, WASHINGTON, D.C. 20231, NO.: EL455157026US

McGLEW AND TUTTLE, P.C.
SCARBOROUGH STATION, SCARBOROUGH, NY 10510-0827

BY: Amy E Sautke DATE: July 27, 2001

(SUBSTITUTE SPECIFICATION)

Docket # 70177

AXLE SUSPENSION FOR RIGID AXLES OF VEHICLES

FIELD OF THE INVENTION

The present invention pertains to an axle suspension for rigid axles of vehicles, especially air-suspension, air cushioned or air sprung utility vehicles, in which a twistable, angulatable or torsionable four-point connecting rod, which is connected in an articulated manner to the vehicle axle, on the one hand, and to the vehicle body, on the other hand, and which is connected by two joints located at spaced locations from one another in the transverse direction of the vehicle to the vehicle axle and to the vehicle body, is arranged above the vehicle axle, at least one axle strut, which extends in the longitudinal direction of

the vehicle and connects the vehicle axle and the vehicle body in a vertically movable manner, is arranged on each side of the vehicle for axle guidance, and at least one spring assembly unit is arranged between the vehicle axle and the vehicle body for springing or suspension.

BACKGROUND OF THE INVENTION

Such axle suspensions of this type have been known from, e.g., DE 195 21 874. The design embodiment of such axle suspensions is, in principle, simple, space- and cost-saving, and has consistently proved successful in practice. However, such an axle suspension forming this type as well as other designs known from the prior art have the drawback that the axle is rigidly connected to the axle struts arranged adjacent to same. In conjunction with the entire axle construction, such a fastening leads to a kinematic overdetermination or redundancy, of the degrees of freedom of the vehicle chassis. This in turn leads to the course of the kinetic processes within the axle construction being undefined in certain situations, which may have an adverse effect on the coordination of the chassis and the chassis dynamics in the vertical and lateral directions.

Moreover, the kinematic overdetermination may lead to vibrations of the drive shaft with a resulting increase in the wear of the drive shaft and high load of the axle housing used in the case of driven axles.

SUMMARY AND OBJECTS OF THE INVENTION

The technical object of the present invention is to improve an axle suspension of this type such that the kinematic conditions are improved in order to optimize the dynamics of the vehicle movement and to achieve reduced vibrations and reduced wear as well as increased lateral rigidity of the axle construction. In addition, the number of the individual parts shall be further reduced, the ease of repair shall be increased and the unsprung or unsuspended weights shall be further reduced.

According to the present invention, the axle strut shall be connected to the vehicle axle by a molecular joint. Contrary to the axle constructions known from the prior art, the articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and an unambiguous assignment or association of the kinematic conditions under all driving conditions, so that the inward and outward deflections of the axle as well as the pendular behavior are not adversely affected by squeezing, or jamming, or twisting of the vehicle axle.

It proved to be especially advantageous, in particular, that the axle struts have a mount or support for the spring assembly unit used and/or a shock absorber. The axle struts are extended for this purpose beyond the articulation point for the end connecting the axle strut to the vehicle axle at their free end not articulated to the vehicle body, and the spring assembly unit usually arranged separately between the vehicle axle and the vehicle body in prior-art constructions is accommodated at this end. The mount or support of the spring assembly unit may have a rigid or articulated design according to the present invention, and

an articulated connection additionally reduces the wear of the spring assembly unit. This functional integration leads, furthermore, to a reduction in the number of components and thus to a reduction of the costs of the entire construction of the axle suspension even as a consequence of reduced assembly time and the stocking of a reduced number of parts. The spring assembly units can be optimally connected to the axle used due to the very simple axle design according to the present invention, and it is conceivable to arrange the axle struts in a V-shaped when viewed in three-dimensional space, which leads to an additional lateral stabilization. It is, of course, conceivable in this connection to provide the axle strut not only with a mount or support for one spring assembly unit, but, e.g., four or more spring assembly units, preferably air spring cushion elements in order to spring or cushion the vehicle axle.

To make it possible to adapt the kinematic conditions of the axle suspension to the design embodiment according to the present invention even better, it is, moreover, advantageous for the axle strut to be also fixed on the vehicle body by a molecular joint. This additional molecular joint should preferably have a stiffer joint characteristic than the vehicle axle-side molecular joint of the axle strut, because a cardanic angulation especially of air bellows used as spring elements is reduced hereby.

In addition, a clean design guiding of the parallelogram of both components is possible due to the spatial kinematics of the upper four-point connecting rod and of the lower axle strut with two joints, which in turn has a favorable effect on the overall kinematics of the axle and also offers the vehicle manufacturer ideal conditions for installation. In

particular, the ideal trapezoid shape guiding guarantees that the wear of the cardan universal-joint shaft is kept as low as possible.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Figure 1 is a perspective view of a first exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the front in the direction of the vehicle;

Figure 2 is a perspective view of the axle suspension according to Figure 1 when viewed obliquely at the rear;

Figure 3 is a top view of another exemplary embodiment of the axle suspension according to the present invention;

Figure 4 is a sectional view of a molecular joint used for the axle suspension according to the present invention;

Figure 5 is a perspective view of another exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the

front in the direction of the vehicle; and

Figure 6 is a view corresponding to the direction of arrow VI in Figure 5, but without the wheel of the vehicle.

Figure 7 is a view similar to that of Figure 6, but with spring assemblies both in front of and behind the vehicle axle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, Figure 1 shows the axle suspension according to the present invention on a utility vehicle chassis, not shown specifically here, which is provided with longitudinal beams 1a, 1b. The longitudinal beams 1a and 1b are arranged at laterally spaced locations from one another and are rigidly connected to one another by the crossbeams 2a, 2b. The vehicle axle 3, which is connected to the longitudinal beams 1a, 1b via a four-point connecting rod 4, is arranged under the longitudinal beams 1a and 1b. The four-point connecting rod 4 has, on the whole, four joints 5, 6, 7 and 8, and two joints 5, 6 each are fastened to the vehicle body and two joints 7, 8 to the vehicle axle. The joints fastened to the vehicle axle and to the body are arranged at spaced locations from one another in the transverse direction of the vehicle.

Figure 1 also shows that a respective side brackets 9 and 10, at the lower, free end of which a respective axle strut 11 and 12 is articulated by means of a molecular joint 13 and 14 each, is fastened to each of the two longitudinal beams 1a and 1b.

A molecular joint is, in principle, a joint as is shown as an example as a ball-and-

socket joint in Figure 4. The molecular joint comprises a joint ball 30 located on the inside, a housing 32 surrounding the joint ball, as well as an elastomer 31 arranged between the joint ball 30 and the housing 32. In the exemplary embodiment according to Figure 4, the joint ball 30 has a two-part design, comprising an inner, metallic joint axle 33 and an outer ball 34 consisting of elastomer, which is made in one piece therewith. In another embodiment of the molecular joint, the joint ball 30 may be made of metal as a whole or it may have a cylindrical inner part instead of a ball. Such molecular joints can be correspondingly adapted to the loads acting on the joint by selecting the elastomer arranged between the joint ball 30 and the housing 32. Moreover, recesses, which bring about a specific effect on the joint characteristics, may be provided within the elastomer and/or the housing or on the inner part of the joint at least in some areas. Thus, molecular joints may have, e.g., a reduced damping in one direction and a correspondingly greater damping in at least one direction located offset in relation thereto.

The axle struts 11, 12 articulated to the side brackets 9, 10 by means of the molecular joints 13, 14 are arranged essentially in the horizontal direction and are connected to the axle 3 according to the present invention at their ends facing away from the molecular joints 13, 14 by means of another molecular joint 15, 16 each. The molecular joints 15, 16 have, in principle, the above-described design and make it possible both to absorb longitudinal and vertical forces and angulations, force acting at an angle or cardanics, which are introduced into the chassis by the movements of the axle. Overdetermination or redundancy of the kinematic degrees of freedom is prevented by the movements of the axle, so that a more

optimal forward coordination can be brought about with respect to the chassis dynamics in the vertical and lateral directions.

The view in Figure 2 shows that the axle struts 11, 12 are extended beyond the articulation point for the molecular joints 15 and 16 and have a mount 17 and 18 each for a respective spring assembly unit 19, 20 at their free ends. Furthermore, there is a connection between the axle struts 11, 12 and the vehicle body 1a, 1b via a shock absorber 35, 36 each. The extension of the axle struts 11 and 12 with the integration of the mounts 17 and 18 leads to a reduction in the number of components usually used in prior-art axle constructions and thus reduces the amount of parts to be stocked and the assembly times for the axle construction according to the present invention. The mounts 17 and 18 may be rigid, or formed by a ball-and-socket or other type of joint.

The top view of another exemplary embodiment of the axle construction according to the present invention in Figure 3 shows that the axle struts 11 and 12 may have a direction extending toward the middle of the vehicle from their front articulation by means of the molecular joints 13 and 14 to the end of the vehicle when viewed in a top view. Moreover, the position of the four-point connecting rod 4 as well as of its articulation points on the body and the axle can be seen in the top view.

It is, of course, possible to also use the articulation according to the present invention of the axle to the axle struts for constructions in which three, four or more such spring elements are used instead of the two spring assembly units shown and in which the spring assembly units 19, 20 are arranged in front of or behind the vehicle axle 3 when viewed in

the direction of the vehicle.

An embodiment with spring assembly units 19 (20) arranged in front of the vehicle axle 3 is shown in Figure 5. The shock absorber 35 (36) is fastened to the mount 18 (17) in this embodiment and the spring assembly unit 19 (20) with an air bellows (air-suspension or air spring) is mounted on the axle strut 12 (11).

Figure 7. Shows an embodiment with spring assemblies 20 (20a) both in front of and behind the vehicle axle.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

ABSTRACT OF THE DISCLOSURE

An axle suspension for rigid axles of vehicles, especially air-suspension (e.g., with air shock absorbers/ air springs) utility vehicles, is presented, in which a twistable four-point connecting rod (4), which is connected in an articulated manner to the vehicle axle (3), on the one hand, and to the vehicle body (1a, 1b), on the other hand, and which is connected to the vehicle axle (3) and to the vehicle body (1a, 1b) by four said joints (5, 6, 7, 8) each located at spaced locations from one another in the transverse direction of the vehicle. The four-point connecting rod is arranged above the vehicle axle (3). At least one axle strut (11, 12), which extends in the longitudinal direction of the vehicle and connects the vehicle axle (3) to the vehicle body (1a, 1b) in a vertically movable manner, is arranged on each side of the vehicle for guiding the axle. At least one air spring assembly unit (19, 20) is arranged between the vehicle axle (3) and the vehicle body (1a, 1b) for spring suspension. The axle struts 11, 12 are each connected to the vehicle axle (3) by a molecular joint (15, 16). The articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and to an unambiguous assignment of the kinematic conditions under all driving conditions, so that an inward and outward deflection of the axle as well as the pendular behavior are not adversely affected by squeezing or jamming of the vehicle axle.

(MARKED UP SPECIFICATION)

Docket # 70177

AXLE SUSPENSION FOR RIGID AXLES OF VEHICLES

~~Specification:~~FIELD OF THE INVENTION

The present invention pertains to an axle suspension for rigid axles of vehicles, especially air-suspension, air cushioned or air sprung utility vehicles, in which a twistable, angulatable or torsionable four-point connecting rod, which is connected in an articulated manner to the vehicle axle, on the one hand, and to the vehicle body, on the other hand, and which is connected by two joints located at spaced locations from one another in the transverse direction of the vehicle to the vehicle axle and to the vehicle body, is arranged above the vehicle axle, at least one axle strut, which extends in the longitudinal direction of the vehicle and connects the vehicle axle and the vehicle body in a vertically movable manner, is arranged on each side of the vehicle for axle guidance, and at least one spring assembly unit is arranged between the vehicle axle and the vehicle body for springing or suspension.

BACKGROUND OF THE INVENTION

Such axle suspensions of this type have been known from, e.g., DE 195 21 874.

The design embodiment of such axle suspensions is, in principle, simple, space- and cost-saving, and has consistently proved successful in practice. However, such an axle suspension forming this type as well as other designs known from the prior art have the drawback that the axle is rigidly connected to the axle struts arranged adjacent to same. In conjunction with the entire axle construction, such a fastening leads to a kinematic overdetermination or redundancy, of the degrees of freedom of the vehicle chassis. This in turn leads to the course of the kinetic processes within the axle construction being undefined in certain situations, which may have an adverse effect on the coordination of the chassis and the chassis dynamics in the vertical and lateral directions.

Moreover, the kinematic overdetermination may lead to vibrations of the drive shaft with a resulting increase in the wear of the drive shaft and high load of the axle housing used in the case of driven axles.

SUMMARY AND OBJECTS OF THE INVENTION

The technical object of the present invention is to improve an axle suspension of this type such that the kinematic conditions are improved in order to optimize the dynamics of the vehicle movement and to achieve reduced vibrations and reduced wear as well as increased lateral rigidity of the axle construction. In addition, the number of the individual parts shall be further reduced, the ease of repair shall be increased and the unsprung or unsuspended weights shall be further reduced.

~~This object is accomplished according to the present invention by the technical teaching of claim 1, in conjunction with the type-forming features.~~ According to the present invention, the axle strut shall be connected to the vehicle axle by a molecular joint. Contrary to the axle constructions known from the prior art, the articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and an unambiguous assignment or association of the kinematic conditions under all driving conditions, so that the inward and outward deflections of the axle as well as the pendular behavior are not adversely affected by squeezing, or jamming, or twisting of the vehicle axle.

~~Special embodiments of the subject of the present invention will also appear from the features of the subclaims.~~

It proved to be especially advantageous, in particular, that the axle struts have a mount or support for the spring assembly unit used and/or a shock absorber. The axle struts are extended for this purpose beyond the articulation point for the end connecting the axle strut to the vehicle axle at their free end not articulated to the vehicle body, and the spring assembly unit usually arranged separately between the vehicle axle and the vehicle body in prior-art constructions is accommodated at this end. The mount or support of the spring assembly unit may have a rigid or articulated design according to the present invention, and

an articulated connection additionally reduces the wear of the spring assembly unit. This functional integration leads, furthermore, to a reduction in the number of components and thus to a reduction of the costs of the entire construction of the axle suspension even as a consequence of reduced assembly time and the stocking of a reduced number of parts. The spring assembly units can be optimally connected to the axle used due to the very simple axle design according to the present invention, and it is conceivable to arrange the axle struts in a V-shaped when viewed in three-dimensional space, which leads to an additional lateral stabilization. It is, of course, conceivable in this connection to provide the axle strut not only with a mount or support for one spring assembly unit, but, e.g., four or more spring assembly units, preferably air spring cushion elements in order to spring or cushion the vehicle axle.

To make it possible to adapt the kinematic conditions of the axle suspension to the design embodiment according to the present invention even better, it is, moreover, advantageous for the axle strut to be also fixed on the vehicle body by a molecular joint. This additional molecular joint should preferably have a stiffer joint characteristic than the vehicle axle-side molecular joint of the axle strut, because a cardanic angulation especially of air bellows used as spring elements is reduced hereby.

In addition, a clean design guiding of the parallelogram of both components is possible due to the spatial kinematics of the upper four-point connecting rod and of the lower

axle strut with two joints, which in turn has a favorable effect on the overall kinematics of the axle and also offers the vehicle manufacturer ideal conditions for installation. In particular, the ideal trapezoid shape guiding guarantees that the wear of the cardan universal-joint shaft is kept as low as possible.

~~Exemplary~~ The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the ~~subject of the present invention will be explained in greater detail below on the basis of the drawings attached. In the drawings,~~

~~Figure 1 shows~~invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Figure 1 is a perspective view of a first exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the front in the direction of the vehicle~~,~~

Figure 2 ~~shows~~is a perspective view of the axle suspension according to Figure 1 when viewed obliquely at the rear~~;~~;

Figure 3 ~~shows~~is a top view of another exemplary embodiment of the axle suspension according to the present invention~~;~~

~~;~~

Figure 4 ~~shows~~is a sectional view of a molecular joint used for the axle suspension according to the present invention~~;~~

~~;~~

Figure 5 ~~shows~~is a perspective view of another exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the front in the direction of the vehicle~~;~~; and

Figure 6 ~~shows~~is a view corresponding to the direction of arrow VI in Figure 5, but without the wheel of the vehicle.

Figure 7 is a view similar to that of Figure 6, but with spring assemblies both in front of and behind the vehicle axle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, Figure 1 shows the axle suspension according to the present invention on a utility vehicle chassis, not shown specifically here, which is provided with longitudinal beams 1a, 1b. The longitudinal beams 1a and 1b are arranged at laterally spaced locations from one another and are rigidly connected to one another by the crossbeams 2a, 2b. The vehicle axle 3, which is connected to the longitudinal beams 1a, 1b via a four-point connecting rod 4, is arranged under the longitudinal beams 1a and 1b. The four-point connecting rod 4 has, on the whole, four joints 5, 6, 7 and 8, and two joints 5, 6 each are fastened to the vehicle body and two joints 7, 8 to the vehicle axle. The joints fastened to the vehicle axle and to the body are arranged at spaced locations from one another in the transverse direction of the vehicle.

Figure 1 also shows that a respective side brackets 9 and 10, at the lower, free end of which a respective axle strut 11 and 12 is articulated by means of a molecular joint 13, and 14 each, is fastened to each of the two longitudinal beams 1a and 1b.

A molecular joint is, in principle, a joint as is shown as an example as a ball-and-socket joint in Figure 4. The molecular joint comprises a joint ball 30 located on the inside, a housing 32 surrounding the joint ball, as well as an elastomer 31 arranged between the joint ball 30 and the housing 32. In the exemplary embodiment according to Figure 4, the joint ball 30 has a two-part design, comprising an inner, metallic joint axle 33 and an outer ball 34 consisting of elastomer, which is made in one piece therewith. In another

embodiment of the molecular joint, the joint ball 30 may be made of metal as a whole or it may have a cylindrical inner part instead of a ball. Such molecular joints can be correspondingly adapted to the loads acting on the joint by selecting the elastomer arranged between the joint ball 30 and the housing 32. Moreover, recesses, which bring about a specific effect on the joint characteristics, may be provided within the elastomer and/or the housing or on the inner part of the joint at least in some areas. Thus, molecular joints may have, e.g., a reduced damping in one direction and a correspondingly greater damping in at least one direction located offset in relation thereto.

The axle struts 11, 12 articulated to the side brackets 9, 10 by means of the molecular joints 13, 14 are arranged essentially in the horizontal direction and are connected to the axle 3 according to the present invention at their ends facing away from the molecular joints 13, 14 by means of another molecular joint 15, 16 each. The molecular joints 15, 16 have, in principle, the above-described design and make it possible both to absorb longitudinal and vertical forces and angulations, force acting at an angle or cardanics, which are introduced into the chassis by the movements of the axle. Overdetermination or redundancy of the kinematic degrees of freedom is prevented by the movements of the axle, so that a more optimal forward coordination can be brought about with respect to the chassis dynamics in the vertical and lateral directions.

The view in Figure 2 shows that the axle struts 11, 12 are extended beyond the

articulation point for the molecular joints 15 and 16 and have a mount 17 and 18 each for a respective spring assembly unit 19, 20 at their free ends. Furthermore, there is a connection between the axle struts 11, 12 and the vehicle body 1a, 1b via a shock absorber 35, 36 each. The extension of the axle struts 11 and 12 with the integration of the mounts 17 and 18 leads to a reduction in the number of components usually used in prior-art axle constructions and thus reduces the amount of parts to be stocked and the assembly times for the axle construction according to the present invention. The mounts 17 and 18 may be rigid, or formed by a ball-and-socket or other type of joint.

The top view of another exemplary embodiment of the axle construction according to the present invention in Figure 3 shows that the axle struts 11 and 12 may have a direction extending toward the middle of the vehicle from their front articulation by means of the molecular joints 13 and 14 to the end of the vehicle when viewed in a top view. Moreover, the position of the four-point connecting rod 4 as well as of its articulation points on the body and the axle can be seen in the top view.

It is, of course, possible to also use the articulation according to the present invention of the axle to the axle struts for constructions in which three, four or more such spring elements are used instead of the two spring assembly units shown and in which the spring assembly units 19, 20 are arranged in front of or behind the vehicle axle 3 when viewed in the direction of the vehicle.

An embodiment with spring assembly units 19, (20) arranged in front of the vehicle axle 3 is shown in Figure 5. The shock absorber 35 (36) is fastened to the mount 18 (17) in this embodiment and the spring assembly unit 19 (20) with an air bellows (air-suspension or air spring) is mounted on the axle strut 12 (11).

~~**List of Reference Numbers:**~~

~~1a Longitudinal beam~~

~~1b Longitudinal beam~~

~~2a Crossbeam~~

~~2b Crossbeam~~

~~3 Vehicle axle~~

~~4 Four-point connecting rod~~

~~5 Joint~~

~~6 Joint~~

~~7 Joint~~

~~8 Joint~~

~~9 Side bracket~~

~~10 Side bracket~~

~~11 Axle strut~~

~~12 Axle strut~~

~~13 Molecular joint~~

~~14 Molecular joint~~

~~15 Molecular joint~~

~~16 Molecular joint~~

~~17 Mount~~

~~18 Mount~~

~~19 Spring assembly unit~~

~~20 Spring assembly unit~~

~~30 Joint ball~~

~~31 Elastomer~~

~~32 Housing~~

~~33 Joint axis~~

~~34 Outer ball~~

~~35 Shock absorber~~

~~36 Shock absorber~~

~~Axle Suspension for Rigid Axles of Vehicles~~

~~Abstract:~~

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

ABSTRACT OF THE DISCLOSURE

An axle suspension for rigid axles of vehicles, especially air-suspension (e.g., with air shock absorbers/ air springs) utility vehicles, is presented, in which a ~~said~~ twistable four-point connecting rod (4), which is connected in an articulated manner to the ~~said~~ vehicle axle (3), on the one hand, and to the ~~said~~ vehicle body (1a, 1b), on the other hand, and which is connected to the ~~said~~ vehicle axle (3) and to the ~~said~~ vehicle body (1a, 1b) by ~~two~~four said joints (5, 6, 7, 8) each located at spaced locations from one another in the transverse direction of the vehicle~~;~~. The four-point connecting rod is arranged above the ~~said~~ vehicle axle (3)~~, a~~. At least one ~~said~~ axle strut (11, 12), which extends in the longitudinal direction of the vehicle and connects the ~~said~~ vehicle axle (3) to the ~~said~~ vehicle body (1a, 1b) in a vertically movable manner, is arranged on each side of the vehicle for guiding the axle ~~and~~ a. At least one ~~said~~ air spring assembly unit (19, 20) is arranged between the ~~said~~ vehicle

axle (3) and the ~~said~~ vehicle body (1a, 1b) for spring suspension~~, wherein t~~. The axle struts 11, 12 are each connected to the vehicle axle (3) by a molecular joint (15, 16 ~~each.~~

). The articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and to an unambiguous assignment of the kinematic conditions under all driving conditions, so that an inward and outward deflection of the axle as well as the pendular behavior are not adversely affected by squeezing or jamming of the vehicle axle.

70177 2

(MARKED UP CLAIMS)

1. ~~A~~ An axle suspension for a rigid ~~axles of vehicles~~ vehicle axle, ~~especially of air-suspension utilityvehicles, in which~~ the axle suspension comprising:

~~a said twistable~~ four-point connecting rod ~~(4), which is connected~~arranged above the vehicle axle;

two vehicle axle joints connecting two points of said four-point connecting rod to said vehicle axle in an articulated manner ~~to the said vehicle axle (3), on the one hand, and to the said vehicle body (1a, 1b), on the other hand, and which is connected to the said vehicle axle (3) and to the said vehicle body (1a, 1b) by two said joints (5, 6, 7, 8) each~~;

two vehicle body joints connecting two points of said four-point connecting rod to a vehicle body in an articulated manner, said two vehicle axle joints being located at spaced locations from one another in ~~the~~a transverse direction of the vehicle~~, is arranged above the said vehicle axle (3), at least one said axle strut (11, 12), which extends in the~~ and said two vehicle body joints being located at spaced locations from one another in a transverse direction of the vehicle;

an first axle strut extending in a longitudinal direction of the vehicle ~~and connects the said vehicle axle (3) to the said vehicle body (1a, 1b) in a vertically movable manner, is~~ arranged on ~~each~~a first side of the vehicle for guiding the axle ~~and at least one said~~, said first axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

an second axle strut extending in a longitudinal direction of the vehicle arranged on a second side of the vehicle for guiding the axle, said second axle strut connecting said vehicle axle to said vehicle body in a vertically movable manner;

a spring assembly unit ~~(19, 20) is~~ arranged between the ~~said~~ vehicle axle ~~(3)~~ and the ~~said~~ vehicle body ~~(1a, 1b)~~ for spring suspension~~;~~

~~**characterized in that**~~

~~the said axle struts (11, 12) are connected to the~~;

a first molecular joint connecting said first axle strut to said vehicle axle ~~(3) by~~ ;

a ~~said~~second molecular joint ~~(15, 16) each.~~

~~2. Axle~~connecting said second axle strut to said vehicle axle.

2. An axle suspension in accordance with claim 1,

~~**characterized in that**~~

~~the said axle struts (11, 12) have a said mount ?? (17, 18) for the~~ further comprising another spring assembly unit arranged between the vehicle axle and the vehicle body for spring suspension, said first axle strut having a first mount for said spring assembly ~~units (19, 20) or said shock absorbers (35, 36).~~

~~3. Axle~~unit and said second axle strut having a second mount for said another spring assembly unit.

3. An axle suspension in accordance with claim 2,

~~**characterized in that**~~
~~the said mounts (17, 18) for the said spring assembly units (19, 20) or the said shock absorbers (35, 36) are designed as joints.~~

~~4. Axle~~ wherein said first mount includes a joint and said second mount includes a joint.

4. An axle suspension in accordance with claim 3,
~~**characterized in that**~~
wherein the joints and~~re~~ ball-and-socket joints.

5. ~~A~~ An axle suspension in accordance with ~~one of the above claims, **characterized in that**~~
~~the said axle struts (11, 12) are additionally connected to the said vehicle body (1a, 1b) via at least one~~claim 1, further comprising a first shock absorber ~~(35, 36) each.~~

~~6. Axle~~connected between said first axle strut and the vehicle body and a second shock absorber connected between said second axle strut and the vehicle body, said first axle strut having a first mount for said first shock absorber and said second axle strut having a second mount for said second shock absorber.

6. An axle suspension in accordance with ~~one of the above claims,~~
~~**characterized in that**~~
~~the said axle struts (11, 12) is connected to the~~claim 1, further comprising:
a third molecular joint connecting said first axle strut to said vehicle body ~~(1a, 1b) by~~ ; and
a ~~said~~forth molecular joint ~~(13, 14) each.~~

~~7. Axle~~connecting said second axle strut to said vehicle body.

7. An axle suspension in accordance with claim 6, ~~**characterized in that**~~
~~the~~wherein said third molecular joint connecting said first axle strut to said vehicle ~~body-side molecular joint (13, 4) of the said axle strut (11, 12)~~body has a stiffer joint characteristic than ~~the~~said first molecular joint connecting said first axle strut to said vehicle ~~axle-side~~axle and said forth molecular ~~joints (15, 16) of the said axle strut (11, 12).~~

~~8. Axle~~joint connecting said second axle strut to said vehicle body has a stiffer joint characteristic than said second molecular joint connecting said second axle strut to said vehicle axle.

8. An axle suspension in accordance with ~~one of the above~~ claims 1,
~~**characterized in that**~~
~~the~~ wherein said spring assembly unit ~~(19, 20)~~ is arranged in front of or behind ~~the~~ said vehicle axle ~~(3)~~.

9. ~~A~~ An axle suspension in accordance with ~~one of the~~ claims 1 ~~through 7,~~
~~**characterized in that**~~
~~a~~, wherein said spring assembly unit ~~(19, 20) each~~ is arranged in front of and behind ~~the~~ said

vehicle axle ~~(3)~~.

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6 PRTS

AXLE SUSPENSION FOR RIGID AXLES OF VEHICLES

Specification:

The present invention pertains to an axle suspension for rigid axles of vehicles, especially air-suspension, air cushioned or air sprung utility vehicles, in which a twistable, angulatable or torsionable four-point connecting rod, which is connected in an articulated manner to the vehicle axle, on the one hand, and to the vehicle body, on the other hand, and which is connected by two joints located at spaced locations from one another in the transverse direction of the vehicle to the vehicle axle and to the vehicle body, is arranged above the vehicle axle, at least one axle strut, which extends in the longitudinal direction of the vehicle and connects the vehicle axle and the vehicle body in a vertically movable manner, is arranged on each side of the vehicle for axle guidance, and at least one spring assembly unit is arranged between the vehicle axle and the vehicle body for springing or suspension.

Such axle suspensions of this type have been known from, e.g., DE 195 21 874. The design embodiment of such axle suspensions is, in principle, simple, space- and cost-saving, and has consistently proved successful in practice. However, such an axle suspension forming this type as well as other designs known from the prior art have the drawback that the axle is rigidly connected to the axle struts arranged adjacent to same. In conjunction with the entire axle construction, such a fastening leads to a kinematic overdetermination or redundancy, of the degrees of freedom of the vehicle chassis. This in turn leads to the course of the kinetic processes within the axle construction being undefined in certain situations, which may have an adverse effect on the coordination of the chassis and the chassis dynamics in the vertical and lateral directions.

Moreover, the kinematic overdetermination may lead to vibrations of the drive shaft with a

resulting increase in the wear of the drive shaft and high load of the axle housing used in the case of driven axles.

The technical object of the present invention is to improve an axle suspension of this type such that the kinematic conditions are improved in order to optimize the dynamics of the vehicle movement and to achieve reduced vibrations and reduced wear as well as increased lateral rigidity of the axle construction. In addition, the number of the individual parts shall be further reduced, the ease of repair shall be increased and the unsprung or unsuspended weights shall be further reduced.

This object is accomplished according to the present invention by the technical teaching of claim 1, in conjunction with the type-forming features. According to the present invention, the axle strut shall be connected to the vehicle axle by a molecular joint. Contrary to the axle constructions known from the prior art, the articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and an unambiguous assignment or association of the kinematic conditions under all driving conditions, so that the inward and outward deflections of the axle as well as the pendular behavior are not adversely affected by squeezing, or jamming, or twisting of the vehicle axle.

Special embodiments of the subject of the present invention will also appear from the features of the subclaims.

It proved to be especially advantageous, in particular, that the axle struts have a mount or support for the spring assembly unit used and/or a shock absorber. The axle struts are extended for this purpose beyond the articulation point for the end connecting the axle strut to the vehicle axle at their free end not articulated to the vehicle body, and the spring assembly unit usually arranged separately between the vehicle axle and the vehicle body in prior-art constructions is accommodated at this end. The mount or support of the spring assembly unit may have a rigid or articulated design according to the present invention, and an articulated connection additionally reduces the wear of the spring assembly unit. This functional integration leads, furthermore, to a

reduction in the number of components and thus to a reduction of the costs of the entire construction of the axle suspension even as a consequence of reduced assembly time and the stocking of a reduced number of parts. The spring assembly units can be optimally connected to the axle used due to the very simple axle design according to the present invention, and it is conceivable to arrange the axle struts in a V-shaped when viewed in three-dimensional space, which leads to an additional lateral stabilization. It is, of course, conceivable in this connection to provide the axle strut not only with a mount or support for one spring assembly unit, but, e.g., four or more spring assembly units, preferably air spring cushion elements in order to spring or cushion the vehicle axle.

To make it possible to adapt the kinematic conditions of the axle suspension to the design embodiment according to the present invention even better, it is, moreover, advantageous for the axle strut to be also fixed on the vehicle body by a molecular joint. This additional molecular joint should preferably have a stiffer joint characteristic than the vehicle axle-side molecular joint of the axle strut, because a cardanic angulation especially of air bellows used as spring elements is reduced hereby.

In addition, a clean design guiding of the parallelogram of both components is possible due to the spatial kinematics of the upper four-point connecting rod and of the lower axle strut with two joints, which in turn has a favorable effect on the overall kinematics of the axle and also offers the vehicle manufacturer ideal conditions for installation. In particular, the idea trapezoid shape guiding guarantees that the wear of the cardan universal-joint shaft is kept as low as possible.

Exemplary embodiments of the subject of the present invention will be explained in greater detail below on the basis of the drawings attached. In the drawings,

Figure 1 shows a perspective view of a first exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the front in the direction of the vehicle,

Figure 2 shows a perspective view of the axle suspension according to Figure 1 when viewed obliquely at the rear,

Figure 3 shows a top view of another exemplary embodiment of the axle suspension according to the present invention,

Figure 4 shows a sectional view of a molecular joint used for the axle suspension according to the present invention,

Figure 5 shows a perspective view of another exemplary embodiment of the axle suspension according to the present invention when viewed obliquely in the front in the direction of the vehicle, and

Figure 6 shows a view corresponding to the direction of arrow VI in Figure 5, but without the wheel of the vehicle.

Figure 1 shows the axle suspension according to the present invention on a utility vehicle chassis, not shown specifically here, which is provided with longitudinal beams 1a, 1b. The longitudinal beams 1a and 1b are arranged at laterally spaced locations from one another and are rigidly connected to one another by the crossbeams 2a, 2b. The vehicle axle 3, which is connected to the longitudinal beams 1a, 1b via a four-point connecting rod 4, is arranged under the longitudinal beams 1a and 1b. The four-point connecting rod 4 has, on the whole, four joints 5, 6, 7 and 8, and two joints 5, 6 each are fastened to the vehicle body and two joints 7, 8 to the vehicle axle. The joints fastened to the vehicle axle and to the body are arranged at spaced locations from one another in the transverse direction of the vehicle.

Figure 1 also shows that a respective side brackets 9 and 10, at the lower, free end of which a respective axle strut 11 and 12 is articulated by means of a molecular joint 13, 14 each, is fastened to each of the two longitudinal beams 1a and 1b.

A molecular joint is, in principle, a joint as is shown as an example as a ball-and-socket joint in Figure 4. The molecular joint comprises a joint ball 30 located on the inside, a housing 32 surrounding the joint ball, as well as an elastomer 31 arranged between the joint ball 30 and the housing 32. In the exemplary embodiment according to Figure 4, the joint ball 30 has a two-part design, comprising an inner, metallic joint axle 33 and an outer ball 34 consisting of elastomer, which is made in one piece therewith. In another embodiment of the molecular joint, the joint ball 30 may be made of metal as a whole or it may have a cylindrical inner part instead of a ball. Such molecular joints can be correspondingly adapted to the loads acting on the joint by selecting the elastomer arranged between the joint ball 30 and the housing 32. Moreover, recesses, which bring about a specific effect on the joint characteristics, may be provided within the elastomer and/or the housing or on the inner part of the joint at least in some areas. Thus, molecular joints may have, e.g., a reduced damping in one direction and a correspondingly greater damping in at least one direction located offset in relation thereto.

The axle struts 11, 12 articulated to the side brackets 9, 10 by means of the molecular joints 13, 14 are arranged essentially in the horizontal direction and are connected to the axle 3 according to the present invention at their ends facing away from the molecular joints 13, 14 by means of another molecular joint 15, 16 each. The molecular joints 15, 16 have, in principle, the above-described design and make it possible both to absorb longitudinal and vertical forces and angulations, force acting at an angle or cardanics, which are introduced into the chassis by the movements of the axle. Overdetermination or redundancy of the kinematic degrees of freedom is prevented by the movements of the axle, so that a more optimal forward coordination can be brought about with respect to the chassis dynamics in the vertical and lateral directions.

The view in Figure 2 shows that the axle struts 11, 12 are extended beyond the articulation point for the molecular joints 15 and 16 and have a mount 17 and 18 each for a respective spring assembly unit 19, 20 at their free ends. Furthermore, there is a connection between the axle struts 11, 12 and the vehicle body 1a, 1b via a shock absorber 35, 36 each. The extension of the axle struts 11 and 12 with the integration of the mounts 17 and 18 leads to a reduction in the number of components usually used in prior-art axle constructions and thus reduces the amount of

parts to be stocked and the assembly times for the axle construction according to the present invention.

The top view of another exemplary embodiment of the axle construction according to the present invention in Figure 3 shows that the axle struts 11 and 12 may have a direction extending toward the middle of the vehicle from their front articulation by means of the molecular joints 13 and 14 to the end of the vehicle when viewed in a top view. Moreover, the position of the four-point connecting rod 4 as well as of its articulation points on the body and the axle can be seen in the top view.

It is, of course, possible to also use the articulation according to the present invention of the axle to the axle struts for constructions in which three, four or more such spring elements are used instead of the two spring assembly units shown and in which the spring assembly units 19, 20 are arranged in front of or behind the vehicle axle 3 when viewed in the direction of the vehicle.

An embodiment with spring assembly units 19, 20 arranged in front of the vehicle axle 3 is shown in Figure 5. The shock absorber 35 (36) is fastened to the mount 18 (17) in this embodiment and the spring assembly unit 19 (20) with an air bellows (air-suspension or air spring) is mounted on the axle strut 12 (11).

List of Reference Numbers:

1a	Longitudinal beam
1b	Longitudinal beam
2a	Crossbeam
2b	Crossbeam
3	Vehicle axle
4	Four-point connecting rod
5	Joint
6	Joint

7	Joint
8	Joint
9	Side bracket
10	Side bracket
11	Axle strut
12	Axle strut
13	Molecular joint
14	Molecular joint
15	Molecular joint
16	Molecular joint
17	Mount
18	Mount
19	Spring assembly unit
20	Spring assembly unit
30	Joint ball
31	Elastomer
32	Housing
33	Joint axis
34	Outer ball
35	Shock absorber
36	Shock absorber

Patent Claims

1. Axle suspension for rigid axles of vehicles, especially of air-suspension utilityvehicles, in which a said twistable four-point connecting rod (4), which is connected in an articulated manner to the said vehicle axle (3), on the one hand, and to the said vehicle body (1a, 1b), on the other hand, and which is connected to the said vehicle axle (3) and to the said vehicle body (1a, 1b) by two said joints (5, 6, 7, 8) each located at spaced locations from one another in the transverse direction of the vehicle, is arranged above the said vehicle axle (3), at least one said axle strut (11, 12), which extends in the longitudinal direction of the vehicle and connects the said vehicle axle (3) to the said vehicle body (1a, 1b) in a vertically movable manner, is arranged on each side of the vehicle for guiding the axle and at least one said spring assembly unit (19, 20) is arranged between the said vehicle axle (3) and the said vehicle body (1a, 1b) for spring suspension,
characterized in that
the said axle struts (11, 12) are connected to the said vehicle axle (3) by a said molecular joint (15, 16) each.

2. Axle suspension in accordance with claim 1,
characterized in that
the said axle struts (11, 12) have a said mount ?? (17, 18) for the said spring assembly units (19, 20) or said shock absorbers (35, 36).

3. Axle suspension in accordance with claim 2,
characterized in that
the said mounts (17, 18) for the said spring assembly units (19, 20) or the said shock absorbers (35, 36) are designed as joints.

4. Axle suspension in accordance with claim 3,
characterized in that

the joints and ball-and-socket joints.

5. Axle suspension in accordance with one of the above claims, **characterized in that** the said axle struts (11, 12) are additionally connected to the said vehicle body (1a, 1b) via at least one shock absorber (35, 36) each.

6. Axle suspension in accordance with one of the above claims,
characterized in that
the said axle struts (11, 12) is connected to the said vehicle body (1a, 1b) by a said molecular joint (13, 14) each.

7. Axle suspension in accordance with claim 6, **characterized in that**
the said vehicle body-side molecular joint (13, 4) of the said axle strut (11, 12) has a stiffer joint characteristic than the said vehicle axle-side molecular joints (15, 16) of the said axle strut (11, 12).

8. Axle suspension in accordance with one of the above claims,
characterized in that
the said spring assembly unit (19, 20) is arranged in front of or behind the said vehicle axle (3).

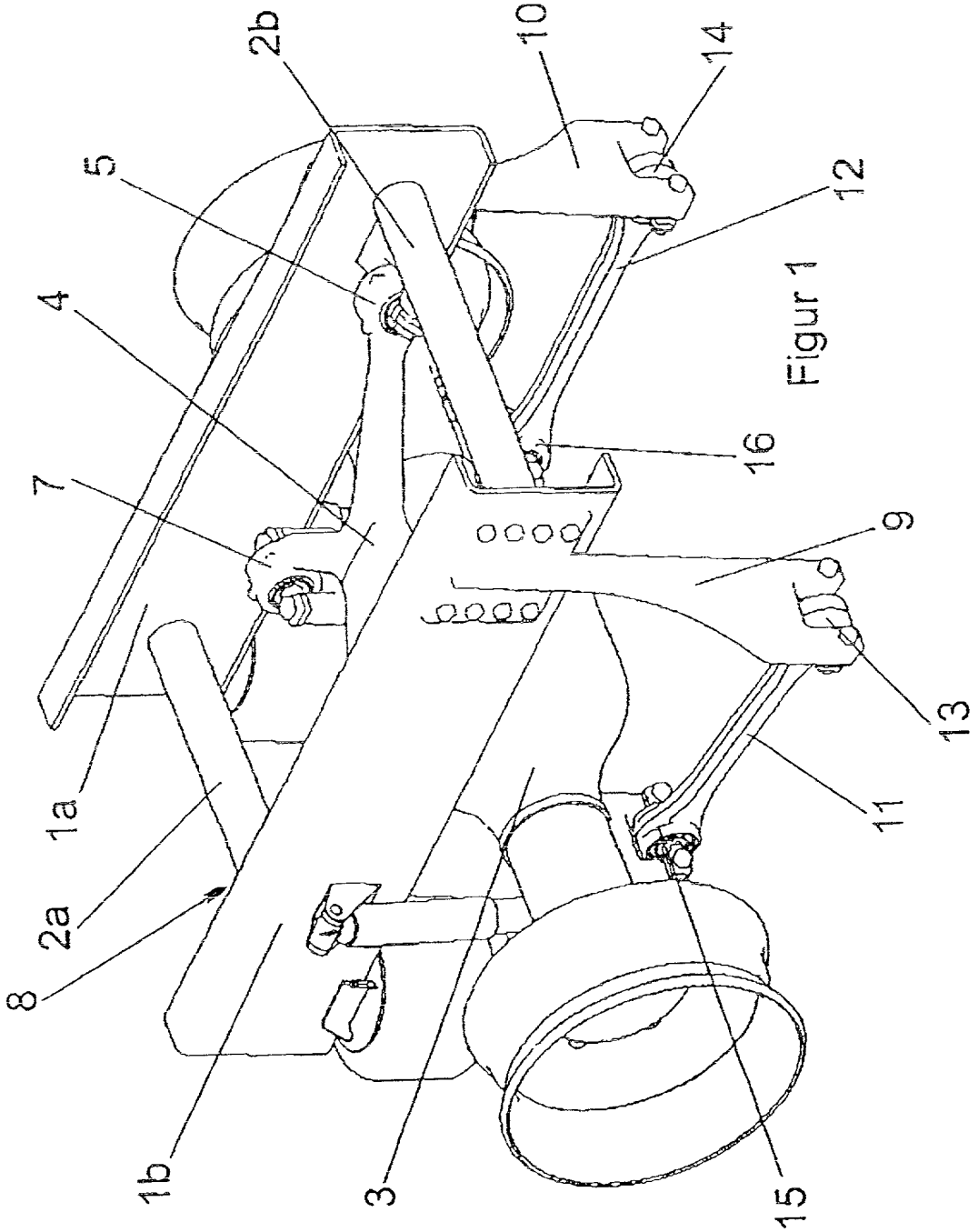
9. Axle suspension in accordance with one of the claims 1 through 7,
characterized in that
a said spring assembly unit (19, 20) each is arranged in front of and behind the said vehicle axle (3).

Axle Suspension for Rigid Axles of Vehicles

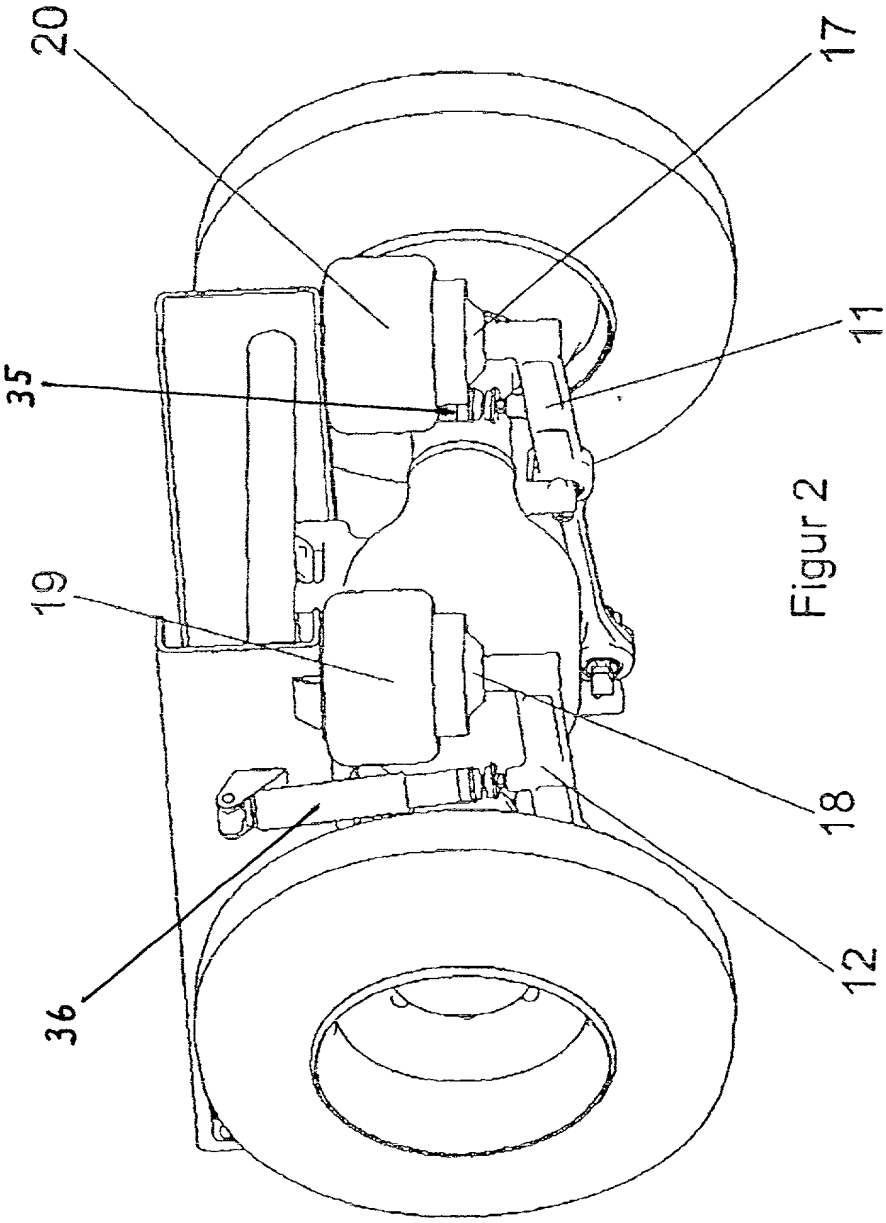
Abstract:

An axle suspension for rigid axles of vehicles, especially air-suspension (e.g., with air shock absorbers/ air springs) utility vehicles, is presented, in which a said twistable four-point connecting rod (4), which is connected in an articulated manner to the said vehicle axle (3), on the one hand, and to the said vehicle body (1a, 1b), on the other hand, and which is connected to the said vehicle axle (3) and to the said vehicle body (1a, 1b) by two said joints (5, 6, 7, 8) each located at spaced locations from one another in the transverse direction of the vehicle, is arranged above the said vehicle axle (3), at least one said axle strut (11, 12), which extends in the longitudinal direction of the vehicle and connects the said vehicle axle (3) to the said vehicle body (1a, 1b) in a vertically movable manner, is arranged on each side of the vehicle for guiding the axle and at least one said air spring assembly unit (19, 20) is arranged between the said vehicle axle (3) and the said vehicle body (1a, 1b) for spring suspension, wherein the axle struts 11, 12 are connected to the vehicle axle 3 by a molecular joint 15, 16 each.

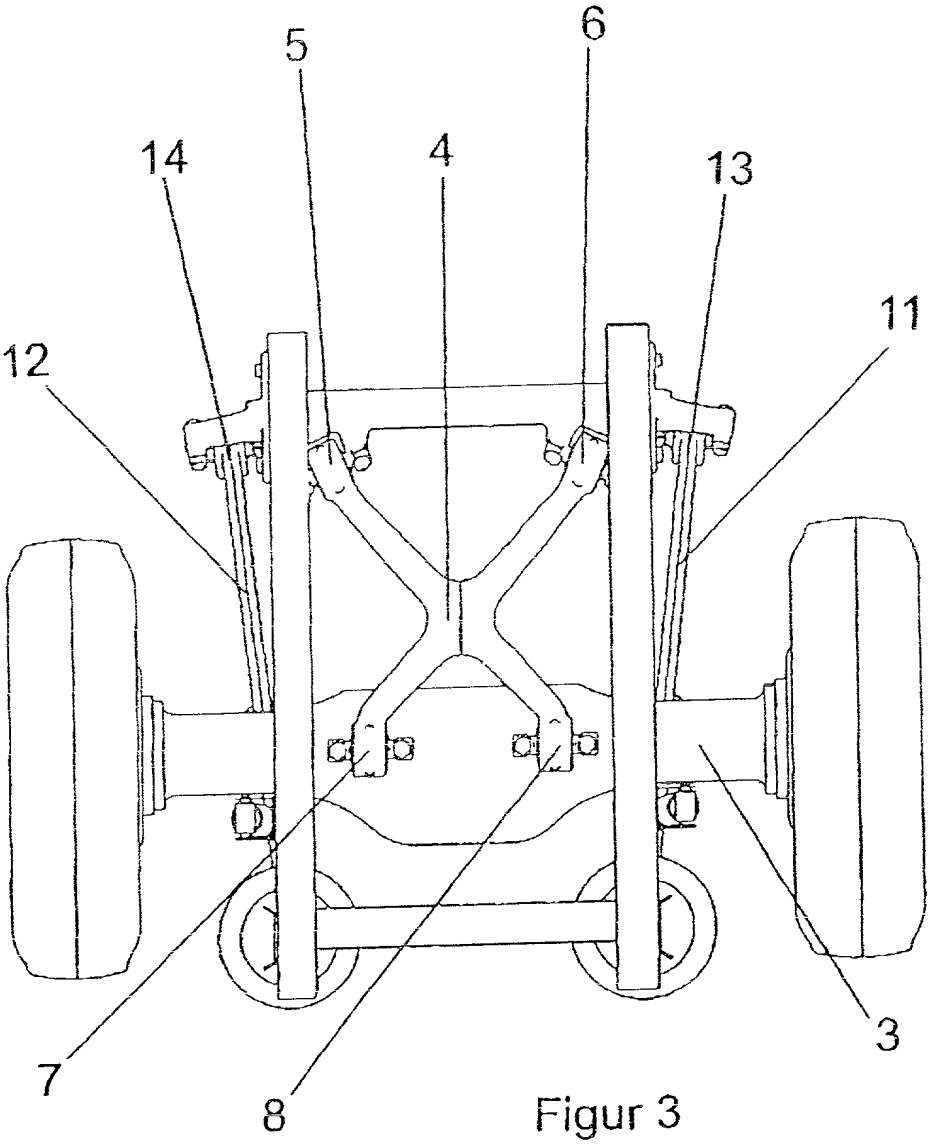
The articulated mounting of the vehicle axle leads to a markedly more favorable elasticity for the entire system of the axle suspension and to an unambiguous assignment of the kinematic conditions under all driving conditions, so that an inward and outward deflection of the axle as well as the pendular behavior are not adversely affected by squeezing or jamming of the vehicle axle.



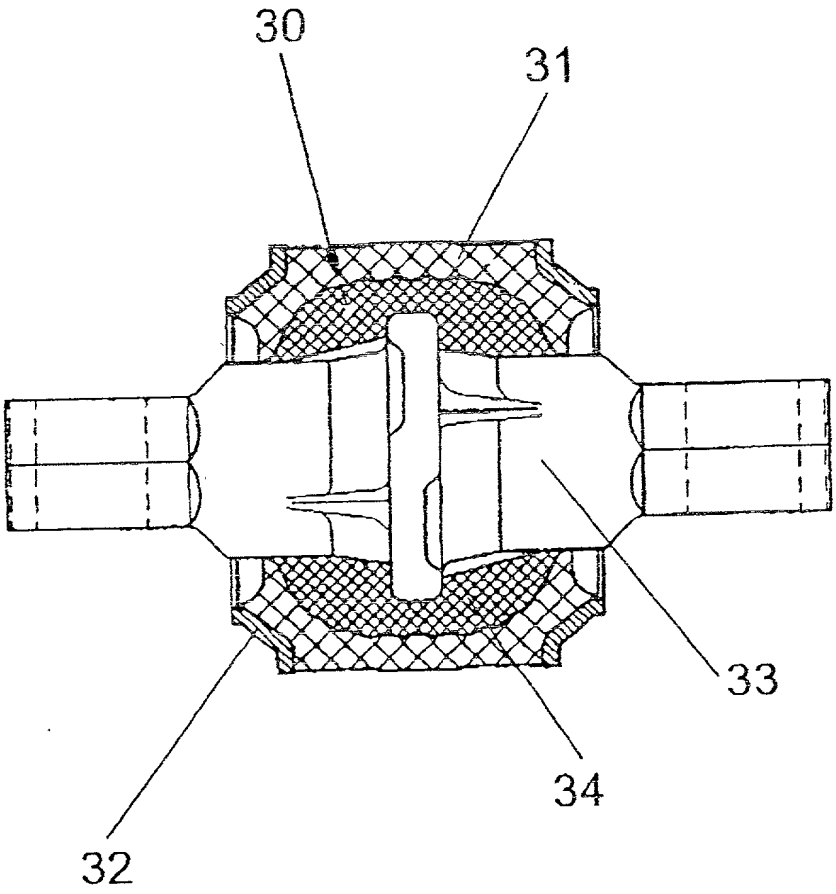
Figur 1



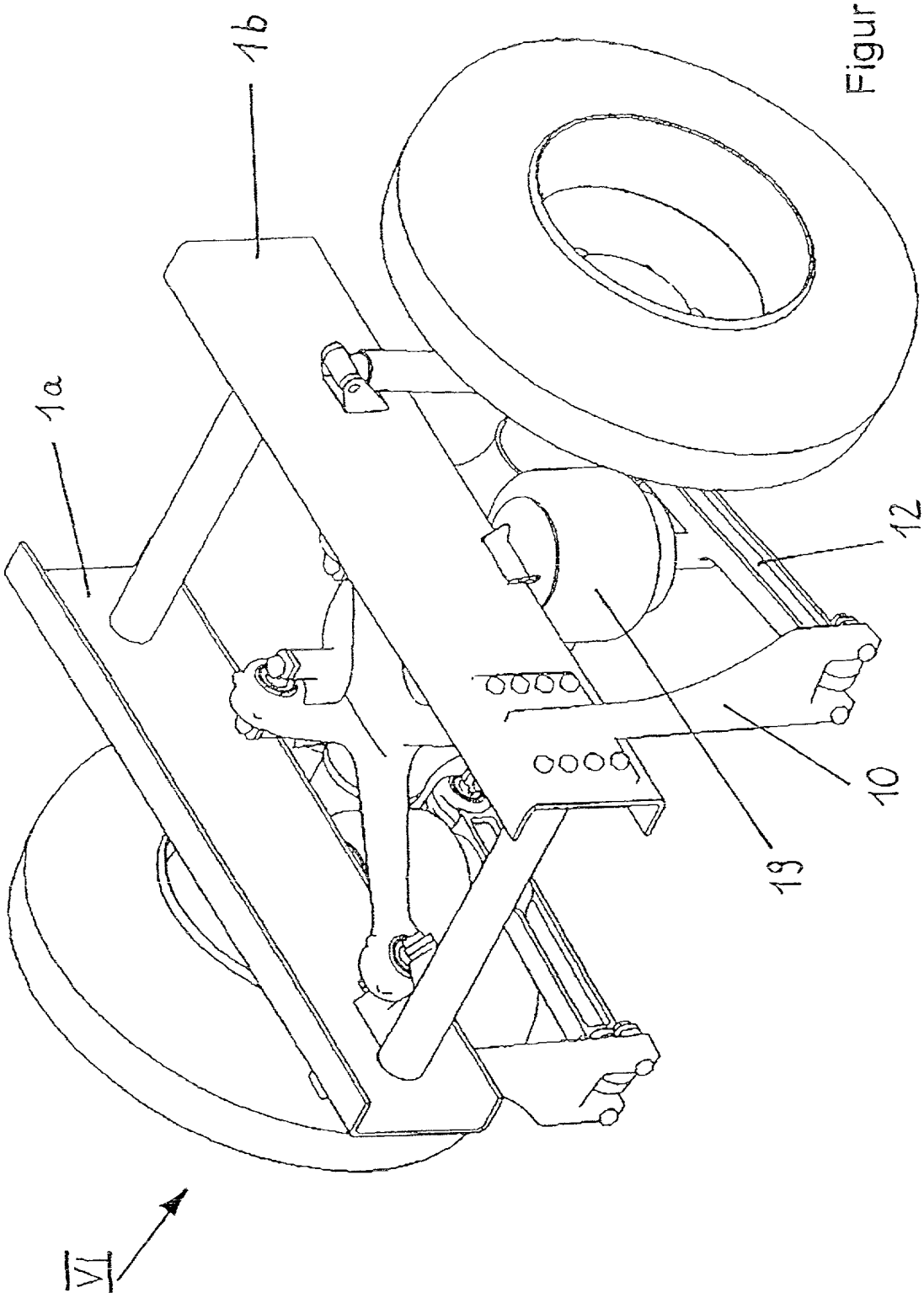
Figur 2



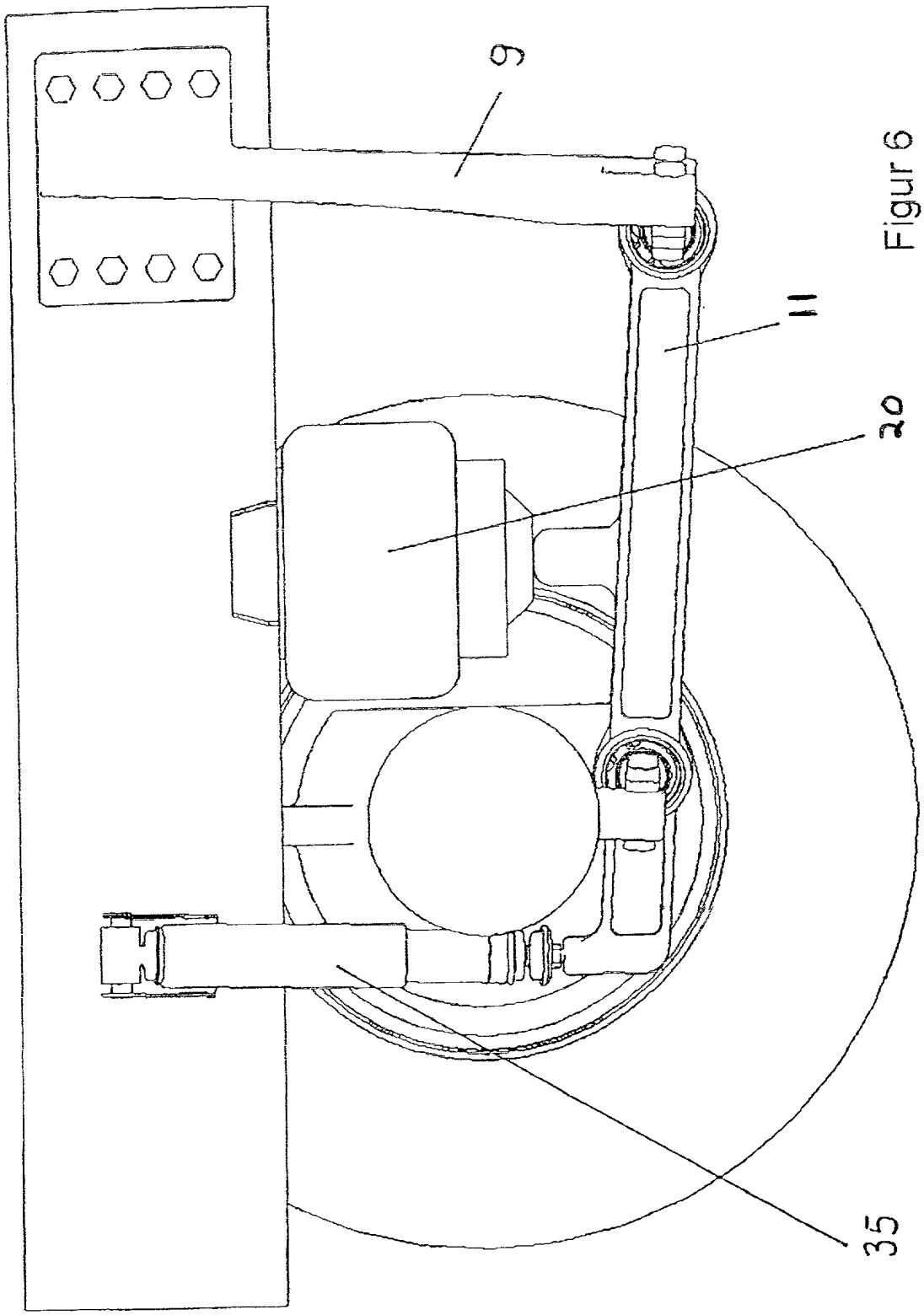
Figur 3



Figur 4



Figur 5



Figur 6

ATTORNEY DOCKET NO: 70177

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	BUHL et al.
Serial No.	:	
Confirm. No.	:	
Filed	:	
For	:	AXLE SUSPENSION...
Art Unit	:	
Examiner	:	
Dated	:	July 27, 2001

Hon. Commissioner of
Patents and Trademarks
Washington, D.C. 20231

LETTER RE DRAWING ADDITIONS

Sir:

Please approve the new figure 7.

Respectfully submitted
for Applicant,

BY: _____
John James McGlew
Reg. No.: 31,903
McGLEW AND TUTTLE, P.C.

JJM:esd
Encls. - Drawing Corrections (1 sheets)

DATED: July 27, 2001
SCARBOROUGH STATION
SCARBOROUGH, NEW YORK 10510-0827
(914) 941-5600

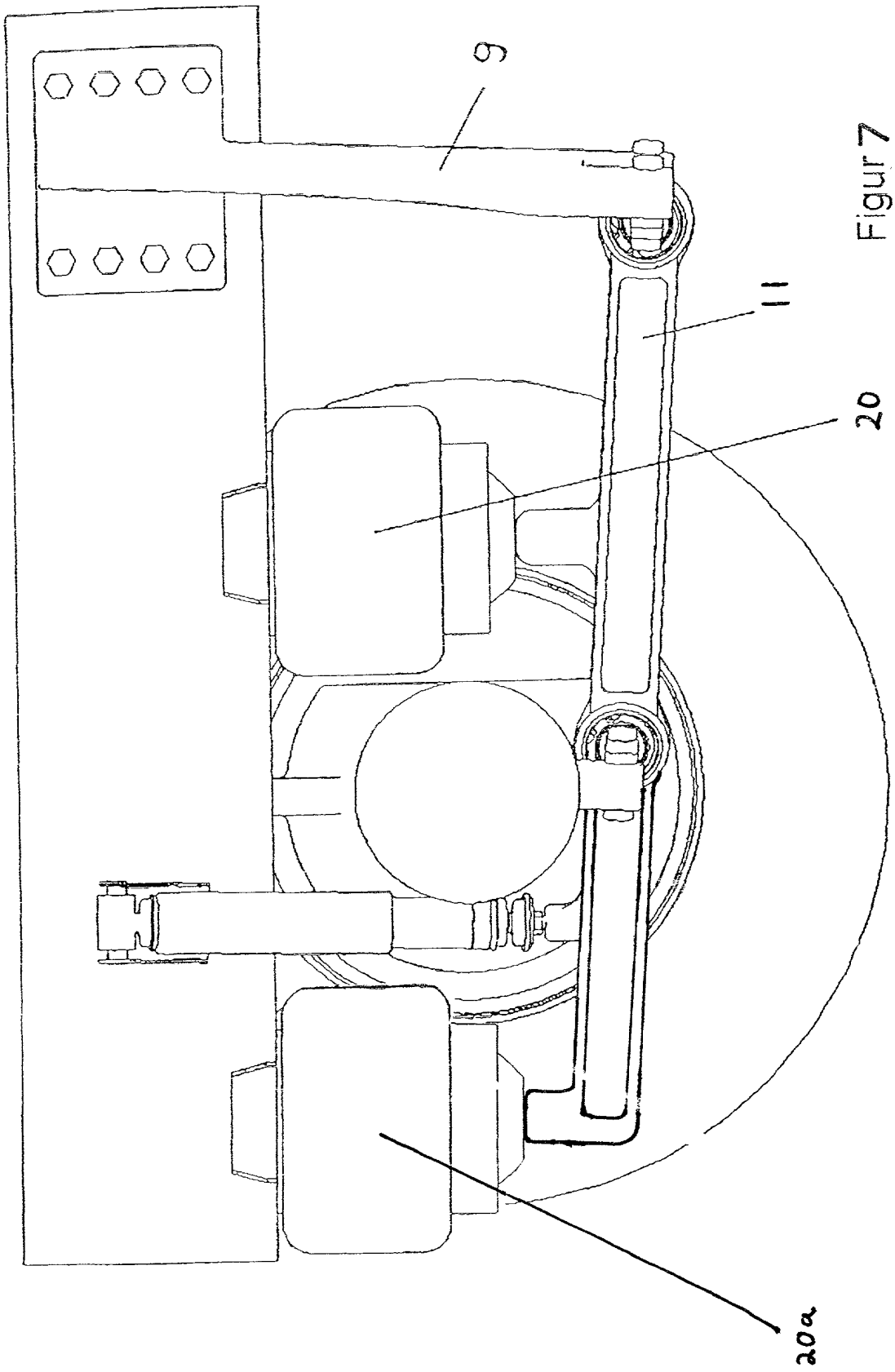
SHOULD ANY OTHER FEE BE REQUIRED, THE PATENT AND TRADEMARK OFFICE IS HEREBY REQUESTED TO CHARGE SUCH FEE TO OUR DEPOSIT ACCOUNT 13-0410.

I HEREBY CERTIFY THAT THIS CORRESPONDENCE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS EXPRESS MAIL NUMBER EL455157026US IN AN ENVELOPE ADDRESSED TO: COMMISSIONER OF PATENTS AND TRADEMARKS, WASHINGTON, D.C. 20231.

McGLEW AND TUTTLE, P.C., SCARBOROUGH STATION
SCARBOROUGH, NY 10510

BY: Amy J. Souther DATE: July 27, 2001

70177.7



Figur 7

DECLARATION FOR PATENT APPLICATION

Docket No.70177

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: *AXLE SUSPENSION FOR RIGID AXLES OF VEHICLES*

the specification of which

(Check one) [ ] is attached hereto.
[X] was filed as PCT international application
Number PCT/DE00/04217
on November 28, 2000
and was amended under PCT Article 19
on _

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 (a)-(d) or 365 (b) of any foreign application(s) for patent or inventor's certificate or 365 (a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date or any PCT international application(s) designating at least one country other than the United States of America by me on the same subject matter having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
DE 199 57 628.9	Germany	30/Nov./1999	Yes
(Number)	(Country)	(Day/Month/Year filed)	

PCT/DE00/04217 (Number)	PCT APPLICATION	November 28, 2000 (Day/Month/Year filed)	YES

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No)	(Filing Date)	(Patented,Pending,Abandoned)
(Application Serial No)	(Filing Date)	(Patented,Pending,Abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: **John J. McGlew, Reg. 17,722; and/or John James McGlew, Reg. 31,903; and/or Hilda S. McGlew Reg. 30,295; and/or Theobald Dengler, Reg. 34,575; and/or Keith D. Moore, Reg. 44,951.**

Address all calls to: John James McGlew at telephone no. (914) 941-5600
Address all correspondence to:

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SCARBOROUGH STATION
SCARBOROUGH, NEW YORK 10510-0827

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-02

Full name of sole or first inventor Reinhard BUHL

→Inventor's signature Reinhard Buhl →Date 23.07.2001

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2.00

Full name of second inventor Holger BUBLIES

→Inventor's signature _____ →Date 23.07.01

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Full name of third inventor

→Inventor's signature _____ →Date _____

Residence Citizenship

Post Office Address

Full name of fourth inventor

→Inventor's signature _____ →Date _____

Residence Citizenship

Post Office Address

Full name of fifth inventor

→Inventor's signature _____ →Date _____

Residence Citizenship

Post Office Address

Full name of sixth inventor

→Inventor's signature _____ →Date _____

Residence Citizenship

Post Office Address

70177.3